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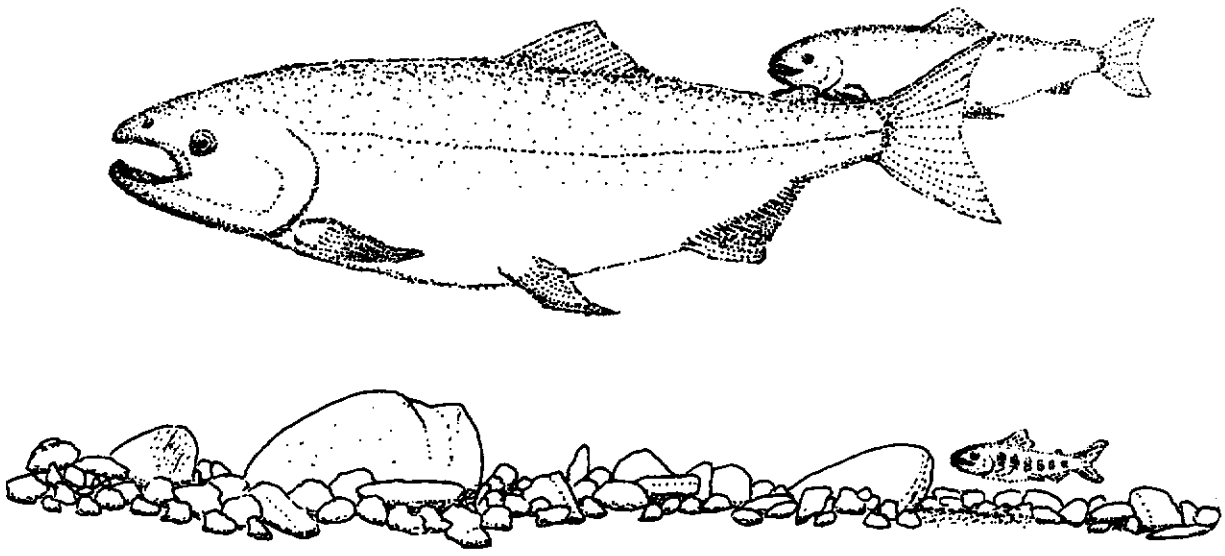
1987 SURVEY AND REDD SURVIVAL RESULTS



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NORTH FORK NOOKSACK SPRING CHINOOK SURVEYS:

1987 SURVEY AND REDD SURVIVAL RESULTS

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INTRODUCTION

This paper presents results of 1987 spring chinook spawning surveys for North Fork Nooksack tributaries and selected mainstem reaches. It also includes a follow-up study that monitored spring chinook redd survival. This was done to better understand redd survival in the unstable, gravel rich North Fork Nooksack drainage.

STUDY AREA

The Nooksack River is located in northwestern Washington State. The North Fork Nooksack is the northernmost of three forks. It originates in the glaciers and snowfields on the north sides of Mt. Shuksan and Mt. Baker. Winter flows are moderate except during major rain-on-snow events; summer flows are higher and often muddy due to runoff from extensive glacial melt.

Most tributaries of the North Fork are high gradient streams which drain steep mountain slopes. Typically they have high winter peak flows, consistent flows during spring and early summer snowmelt, and low clear flows (sometimes drying up) during late summer and early fall. An extensive overview of the N. F. Nooksack mainstem and spring chinook spawning streams including habitat observations and a historical count review can be found in Schuett-Hames and Schuett-Hames (1987).

METHODS

Spawning Ground Surveys

Spawning ground surveys were conducted from August 8th through September 19th, 1987 by walking survey reaches and recording numbers and locations of live and dead chinook and their redds. Most tributary and mainstem reaches were surveyed on a weekly basis. During the latter part of the survey period, more effort was placed on carcass recovery in the mainstem and effort was reduced in tributaries where no fish had been seen.

Fork lengths and scale samples were taken whenever possible from carcasses. Scales were read to determine the age of the fish and the length of fresh water residence. All carcasses were examined for adipose fin clips signifying a coded wire tag, and dorsal fin clips indicating prior scale sampling by the Nooksack Tribe canoe-based survey team. We did not collect scale data from dorsal clipped fish to avoid duplicate sampling. Tails were removed from carcasses to avoid recounting on future surveys. Visual observations of carcass coloration were recorded to allow an estimation of percent of population and timing of two visually distinct North Fork chinook groups to be made.

Redd Survival Studies

Redd survival studies utilized two methods: marking bed elevations of individual redds; and marking channel cross-sections to monitor the bed elevation of a side channel.

Individual Redds. -- Redds used for survival studies were located during foot surveys. Redd elevations were measured as soon as possible after spawning was completed to lessen chances for change through gravel shifting during storms or subsequent spawning events.

Figure 1 shows the method used to monitor redd elevation. Standard survey equipment and techniques were used to measure redd elevations. One to two benchmarks were placed in a tree near the redd. A surveying rod was placed on the benchmark and the elevation was read with a surveying level. Next, the survey rod was placed at the highest point on the middle of the redd mound and the redd elevation was recorded.

These measurements were used to establish redd elevations which could be remeasured at a later date to document changes indicating scour or deposition at the redd site.

To allow the exact location to be remeasured on subsequent visits, two rebar stakes or nails in trees were placed on the upper banks. Tape measures were stretched from these points and joined over the spot on the redd used for the elevation measurement. The distance at which each tape joined the other as well as a compass direction along the tape to the rebar or nail was recorded.

To allow documentation of any channel changes a channel width over the redd was taken with the tape measure attached to one of the rebars or nails.

Sites were revisited twice during the winter, coinciding with mid-incubation and emergence. Channel widths were remeasured as were benchmark and redd elevations. Redds were relocated by finding the exact point where the two tape-measured distances intercepted. Visual observations of any changes to the stream were recorded.

Cross-sections. -- In one side-channel of the North Fork used extensively for spawning, redds could not be located due to poor water visibility. Three representative channel cross-sections were established in this side channel to document changes in the substrate elevation. The intent was for any changes in the channel cross-sections to be indicators of changes to the redds within the channel. At each cross-section elevations were measured at a minimum of ten equal points across the channel. The cross-sections were located with a tape which ran from the benchmark nail, by compass bearing, across the channel. Elevations along the tape were read with a surveying level and rod.

Cross-sections were revisited twice. The data was computerized and graphically plotted.

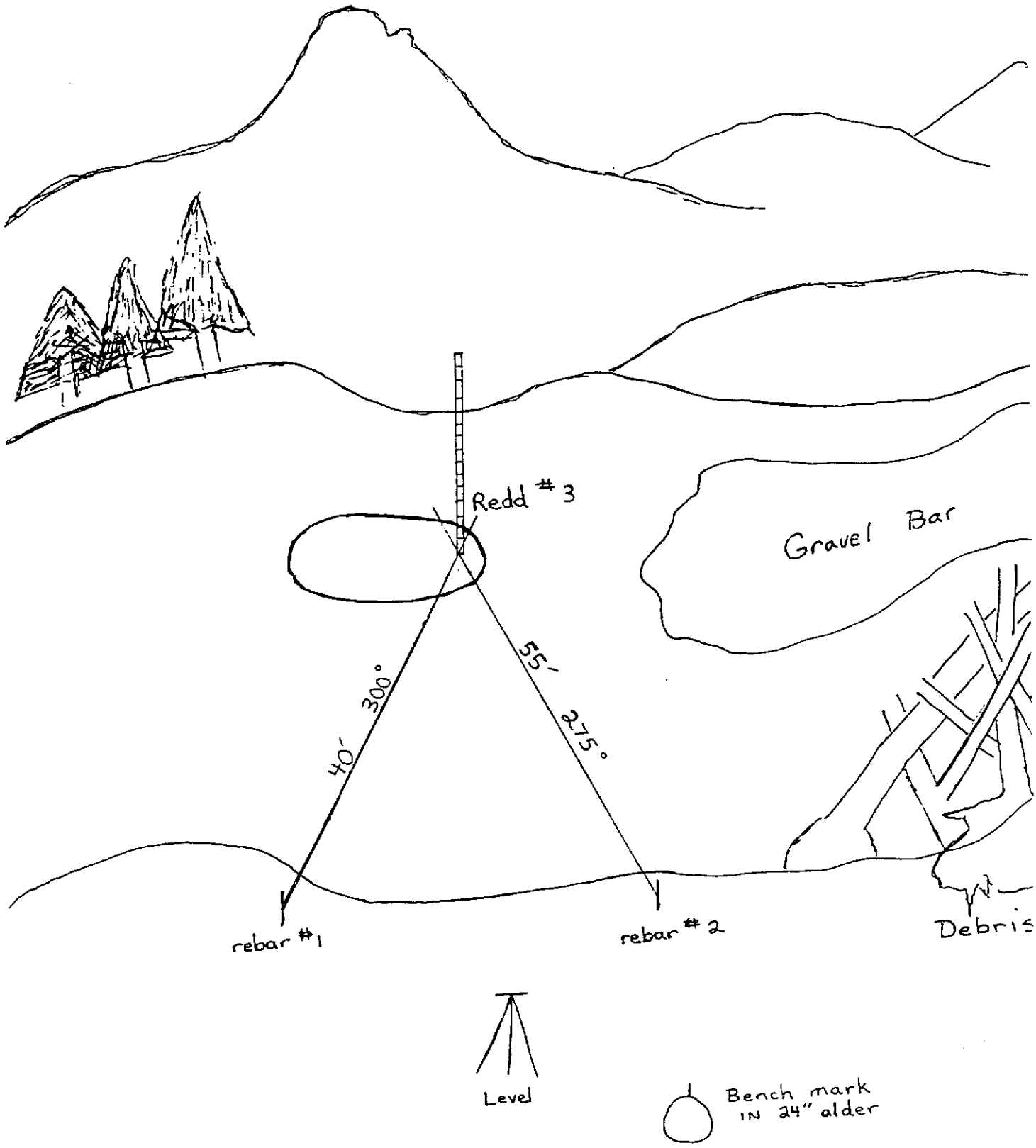

Figure 1. Monitoring of select spring chinook redds for levels of deposition during fall and winter 1987-1988.

RESULTS

Spawning Ground Surveys

Appendix I presents locations, dates and results of the 1987 North Fork Nooksack spring chinook surveys. Surveys were done on 15 tributaries, and 21 North Fork reaches.

Spring chinook were observed in only two tributaries: Canyon Creek (RM 0.7-1.0); and, Kendall Creek (RM 0.0-0.2). Spring chinook were observed in the North Fork at eight locations between RM 44.5 (Coal vicinity) and RM 55.4 (Canyon vicinity).

Survey and visibility conditions were good in the tributaries (except Glacier Creek) throughout the survey period. North Fork Nooksack conditions were poor until the third week of September when the river lowered and visibility improved. Total effort for the survey period was 28 surveyor days; 68 total rivermiles were covered.

Table 1 shows the 1987 area totals for survey reaches in which spring chinook were observed. These figures were developed using the highest live and/or dead count for the reach. In cases where the estimated total for a sub-area based on redd counts (assuming two fish per redd based on field observations) exceeded the number of fish actually observed, the redd count estimate was used as an upper range and is shown in parenthesis. The total derived is dependent upon factors such as visibility and accessibility and therefore is not a population estimate.

A total of 62 spring chinook were accounted for in the 1987 North Fork area spring chinook surveys (with a range of up to 64 using redd count data). In the North Fork Nooksack 46 were observed, while 16 (to 18) were observed in the two tributaries, Canyon and Kendall Creek. The greatest concentrations of spring chinook were seen in the following areas: the North Fork at RM 52.2-52.5 (upper Boulder vicinity) with 21; Kendall Creek with 11 (to 12); the North Fork at RM 46.9-47.6 (Kendall Farmhouse vicinity) with 7; Canyon Creek with 5 (to 6); and the North Fork at RM 51.5-52.2 (lower Boulder vicinity) with 5.

Table 2 gives information on carcass recoveries, including date, rivermile, fork length, age, sex, presence of dorsal clip, and carcass coloration. Approximate location of carcass recoveries is shown in Figure 2.

Forty-two carcasses were recovered. Fork lengths ranged from 98cm to 68cm with a mean of 81.3cm. No carcasses had adipose clips. Three carcasses had dorsal clips indicating prior sampling by Nooksack Tribal canoe based surveys.

Scales were read to determine ages of 24 carcasses. Twelve fish (50%) were 5 years old; 10 fish (42%) were four years old, one fish (4%) was three years old and one fish (4%) was two years old. Two fish (8%) had two springs of fresh water residence; the remaining 92% out-migrated during their first year.

Table 1. USFWS 1987 North Fork Nookaack chinook survey area totals, (using highest live, dead or redd counts). Please note this is not a population estimate; actual populations are likely substantially higher. Areas without sightings are not included.

Area	Type of Count (Number)	# of Fish Represented
Canyon Cr.	Live (5); Redd (3)	5 (to 6)
Kendall Cr.	Dead (11); Redd (6)	11 (to 12)
N.F. Nookaack		
Racehorse	Dead (2)	2
Coal Creek Vicinity	Dead (2)	2
Kendall Hatchery	Live (3)	3
Kendall Farmhouse (Harris Farm)	Dead (7)	7
Upper Kendall Farmhouse / Glen	Dead (4)	4
Boulder, Lower	Dead (5)	5
Boulder, Upper	Live (21)	21
Canyon Vicinity	Dead (2)	2
	Fish Total	62 (to 64)

Table 2. North Fork Nooksack 1987 spring chinook carcass recovery (U.S. Fish and Wildlife Service).

CARCASS NUMBER	STREAM (WRIA#)	RIVERMILE	DATE	SEX	LENGTH (CM)	AGE*	DORSAL CLIP**	GREEN*** NO	GREEN*** YES
1.	N.F. Nooksack (0120)	52.3	Aug. 28	M	72	4(1)		X	
2.	N.F. Nooksack (0120)	55.1	Aug. 30	F	70	4(2)		X	
3.	N.F. Nooksack (0120)	52.3 - RBSC	Sept. 4	F	82		X	X	
4.	N.F. Nooksack (0120)	52.3 - RBSC	Sept. 4	F	98	5(1)		X	
5.	N.F. Nooksack (0120)	45.4	Sept. 6	M	86			X	
6.	N.F. Nooksack (0120)	45.5	Sept. 6	F	80	4(1)		X	
7.	Canyon Cr. (0437)	00.8	Sept. 7	F	89	5(1)		X	
8.	N.F. Nooksack (0120)	47.4 - LBSC	Sept. 7		86	5(1)		X	
9.	N.F. Nooksack (0120)	47.4 - LBSC	Sept. 7			5(1)		X	
10.	N.F. Nooksack (0120)	47.5	Sept. 7		69			X	
11.	N.F. Nooksack (0120)	47.6	Sept. 7	F	84	4(1)		X	
12.	N.F. Nooksack (0120)	48.2	Sept. 7	M	87			X	
13.	Kendall Cr. (0406)	00.0	Sept. 11	M	82			X	
14.	Kendall Cr. (0406)	00.1	Sept. 11	M	80			X	
15.	Kendall Cr. (0406)	00.1	Sept. 11	M	85	5(1)		X	
16.	Kendall Cr. (0406)	00.1	Sept. 11	F	72	4(1)		X	
17.	Kendall Cr. (0406)	00.1	Sept. 11	F	84			X	
18.	Kendall Cr. (0406)	00.1	Sept. 11		70			X	
19.	Kendall Cr. (0406)	00.2	Sept. 11	F	69	4(1)			X
20.	N.F. Nooksack (0120)	51.6 - RBSC	Sept. 12	M	68	3(1)		X	
21.	N.F. Nooksack (0120)	51.8	Sept. 12						
22.	N.F. Nooksack (0120)	52.2	Sept. 12	F	85	5(1)		X	
23.	N.F. Nooksack (0120)	52.2	Sept. 12	F	84	4(1)			X
24.	N.F. Nooksack (0120)	52.3 - RBSC	Sept. 12	F	74		X	x	
25.	N.F. Nooksack (0120)	52.4 - RBSC	Sept. 12	F	83		X		X
26.	N.F. Nooksack (0120)	47.2 - LBSC	Sept. 14	F	89	5(1)		X	
27.	N.F. Nooksack (0120)	48.1	Sept. 14		87	5(1)		X	
28.	N.F. Nooksack (0120)	48.2	Sept. 14	M	72			X	
29.	N.F. Nooksack (0120)	55.4	Sept. 14					X	
30.	Kendall Cr. (0406)	00.0	Sept. 18	M	81			X	
31.	Kendall Cr. (0406)	00.0	Sept. 18	M	79			X	
32.	Kendall Cr. (0406)	00.1	Sept. 18	F	93	5(1)			X
33.	Kendall Cr. (0406)	00.1	Sept. 18	M	81	4(1)		X	
34.	N.F. Nooksack (0120)	44.5	Sept. 18	M	78	4(1)		X	
35.	N.F. Nooksack (0120)	44.5	Sept. 18	M	82			X	
36.	N.F. Nooksack (0120)	45.8 - RBSC	Sept. 18	F	80			X	
37.	N.F. Nooksack (0120)	47.1	Sept. 19	M	92	5(1)		X	
38.	N.F. Nooksack (0120)	47.3	Sept. 19	F	96	5(2)			
39.	N.F. Nooksack (0120)	47.4	Sept. 19	F	91	5(1)		X	
40.	N.F. Nooksack (0120)	51.7	Sept. 19	M	79	4(1)			X
41.	N.F. Nooksack (0120)	52.2 - RBSC	Sept. 19	M	81			X	
42.	N.F. Nooksack (0120)	52.5 - RBSC	Sept. 19	M	71	2(1)		X	

* Number in parenthesis equals springs of freshwater residence.

** This field season a dorsal clip indicated prior carcass sampling by the Nooksack Tribal canoe based surveys.

*** Two visually distinct groups of chinook were found during the survey period. Refer to report results.

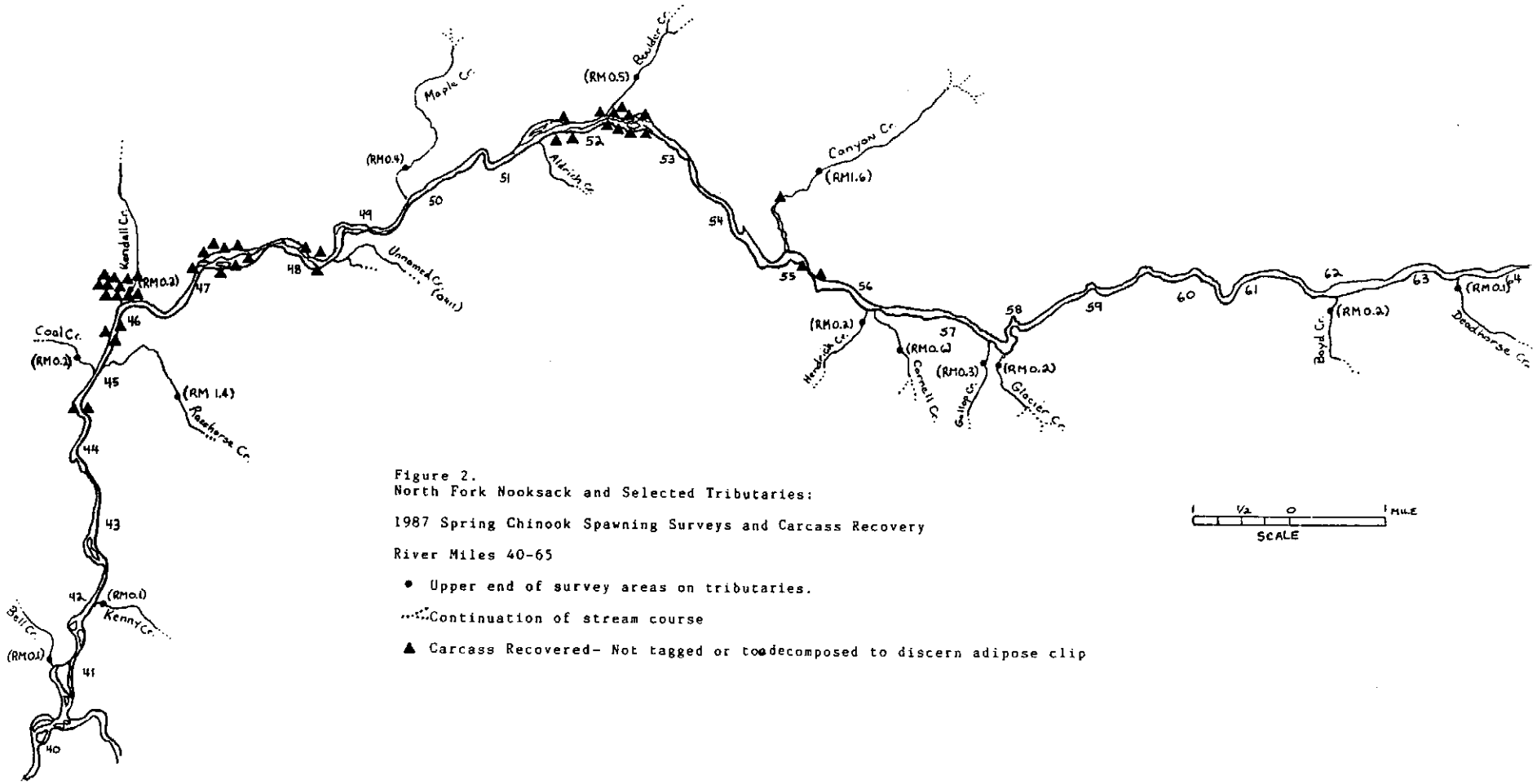

Figure 2.
North Fork Nooksack and Selected Tributaries:

1987 Spring Chinook Spawning Surveys and Carcass Recovery

River Miles 40-65

• Upper end of survey areas on tributaries.

Continuation of stream course

▲ Carcass Recovered- Not tagged or too decomposed to discern adipose clip

Visual observation of carcasses was used to distinguish two distinct subgroups of chinook. The majority were not bright (dull silver to black in coloration) and were recovered from August 28 to September 19. As in previous years, a small group of visually distinct bright green chinook was also observed. They occurred during the last nine days of the survey period (September 11-19). The identity of these fish remains an enigma (see discussion in Schuett-Hames and Schuett-Hames, 1987).

Redd Survival Studies

Eight redds were located during foot surveys and were subsequently marked. Two of these redds were in side channels of the North Fork; three were in Canyon Creek; and three in Kendall Creek. During the study, markers on one Kendall Creek redd were lost and that site was removed from analysis. In addition to marking of individual redds, a side-channel of the North Fork was monitored with three cross-sections between rivermiles 52.3-52.4. This channel had a minimum of 21 chinook spawning within 0.3 rivermiles, making it the largest congregation of spawners in the North Fork this year.

Table 3 shows results from the redd monitoring. The results are very favorable for the 1987 brood year in the North Fork. Out of seven redds only two had significant changes in either flow or elevation. These were both characterized as having "partial" redd survival meaning some of the eggs were likely lost but a portion should have survived. One of these was in Kendall Creek where scouring appeared to be related to subsequent spawning events. The other was in a channel of the North Fork Nooksack where a drop in water level had partially dried out the top of the redd and a 1-4" crust of sand had been deposited at the front of the redd.

The cross-section results are also positive for redd survival. Figures 3, 4 and 5 show diagramatically the changes in cross-section elevations. Two cross-sections represented full survival of redds; one represented a possibility of partial survival. In general, monitoring of the three cross-sections documented that the spawning channel used by the main congregation of spawning North Fork spring chinook stayed relatively stable and intact through the incubation period.

No substantial changes in channel width or location were documented.

DISCUSSION

Comparison of 1985 - 1987 Counts

Developing population estimates for the North Fork Nooksack spring chinook spawning population has been difficult. The North Fork Nooksack is usually extremely turbid during the spring chinook spawning period due to glacial flour which makes salmon difficult to

Table 3. Spring chinook redd survival at individual redd locations in the North Fork Nooksack, 1987 - 88.

LOCATION	REDD NUMBER	CHANGES IN BED ELEVATION (FT.)* EARLY INCUBATION PERIOD	CHANGES IN BED ELEVATION (FT.)* LATE INCUBATION PERIOD	OBSERVATIONS	PROBABLE SURVIVAL OF REDD
N.F. Upper Boulder	1	-0.2	+0.1	Flow dropped during incubation leaving top of redd dry and 1 - 4" of sand encassing the front of the redd. If subsurface flows were adequate, fish could have survived.	Partial
N.F. Upper Kendall	1	-0.1	0.0	Channel looked unchanged during incubation.	Yes
Canyon Creek	1	0.0	0.0	Stream looked unchanged during incubation.	Yes
	2	+0.3	+0.2	Stream looked unchanged during incubation.	Yes
	3	+0.7	+0.6	Location looked O.K.	Yes
Kendall Creek	1	-0.8	-0.8	Change in elevation likely due to heavy subsequent spawning by fall chinook, coho and chum.	Partial
	2	-0.1	-0.3	Heavy subsequent spawning in this area.	Yes
N.F. Upper Boulder	CS1**	-0.3 to +0.2	-0.2 to +0.3	No change noted.	Yes
	CS2**	-0.7 to 0.0	-0.9 to 0.0	Most of cross-section looks good; it is possible one large rock could be responsible for the change noted.	Partial
	CS3**	***	+0.6 to +1.3	Visually the location did not look changed. Because the change occurred as aggradation and not scour, and because the particle size appeared large, it is likely eggs would have survived successfully.	Yes

* Changes noted in the bed elevation are relative to the initial marking elevation of the redd or cross-section. The early incubation period represents the period between marking (late September to early October, and mid-December; late incubation refers to mid-December through mid-February.

** CS1, 2 and 3 represent the cross-section results. The range is given for changes within the portion of the cross-section characterized as spawning riffle.

*** No data taken in December; therefore the information under "late incubation" represents both early and late.

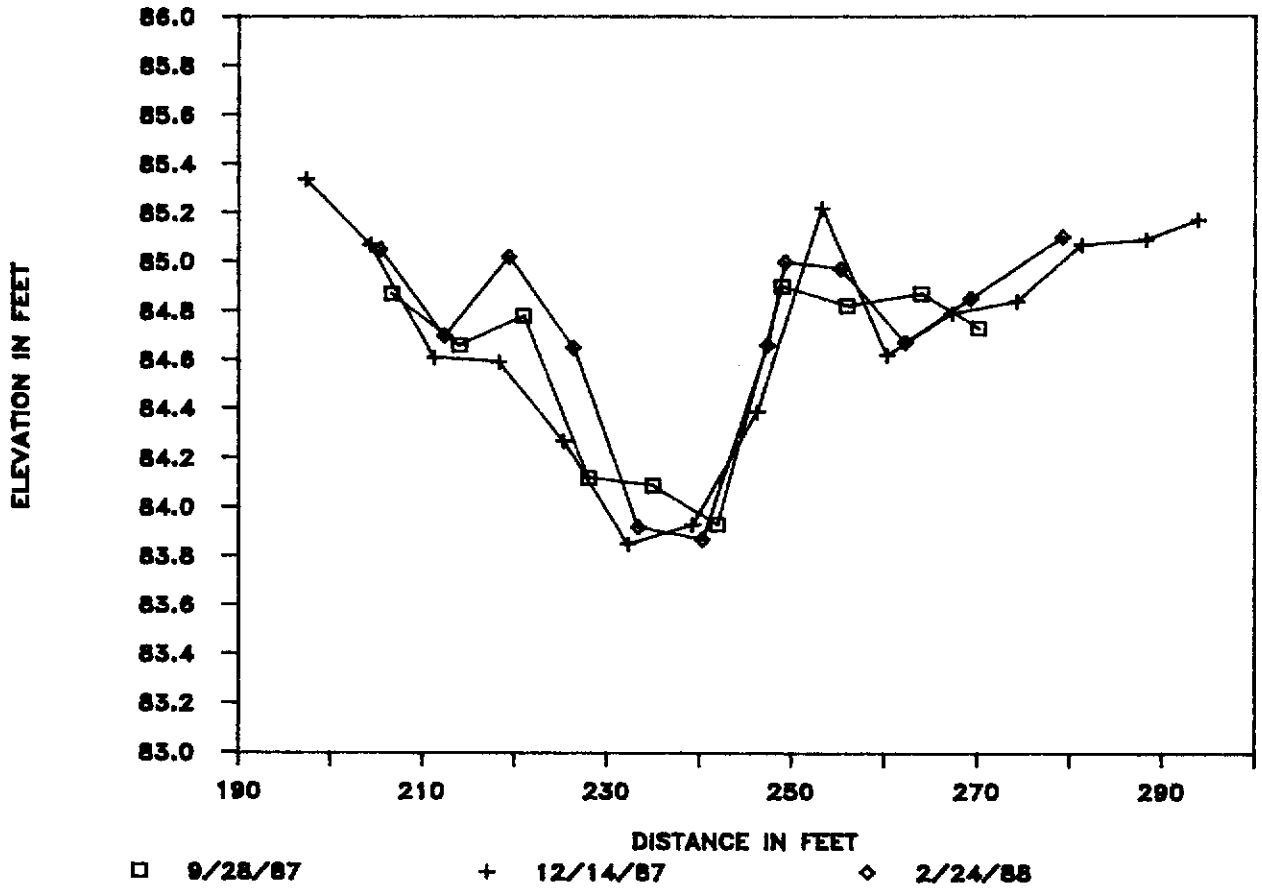

Figure 3. Changes in streambed elevation at North Fork Nooksack side-channel cross-section #1 during the spring chinook egg incubation period.

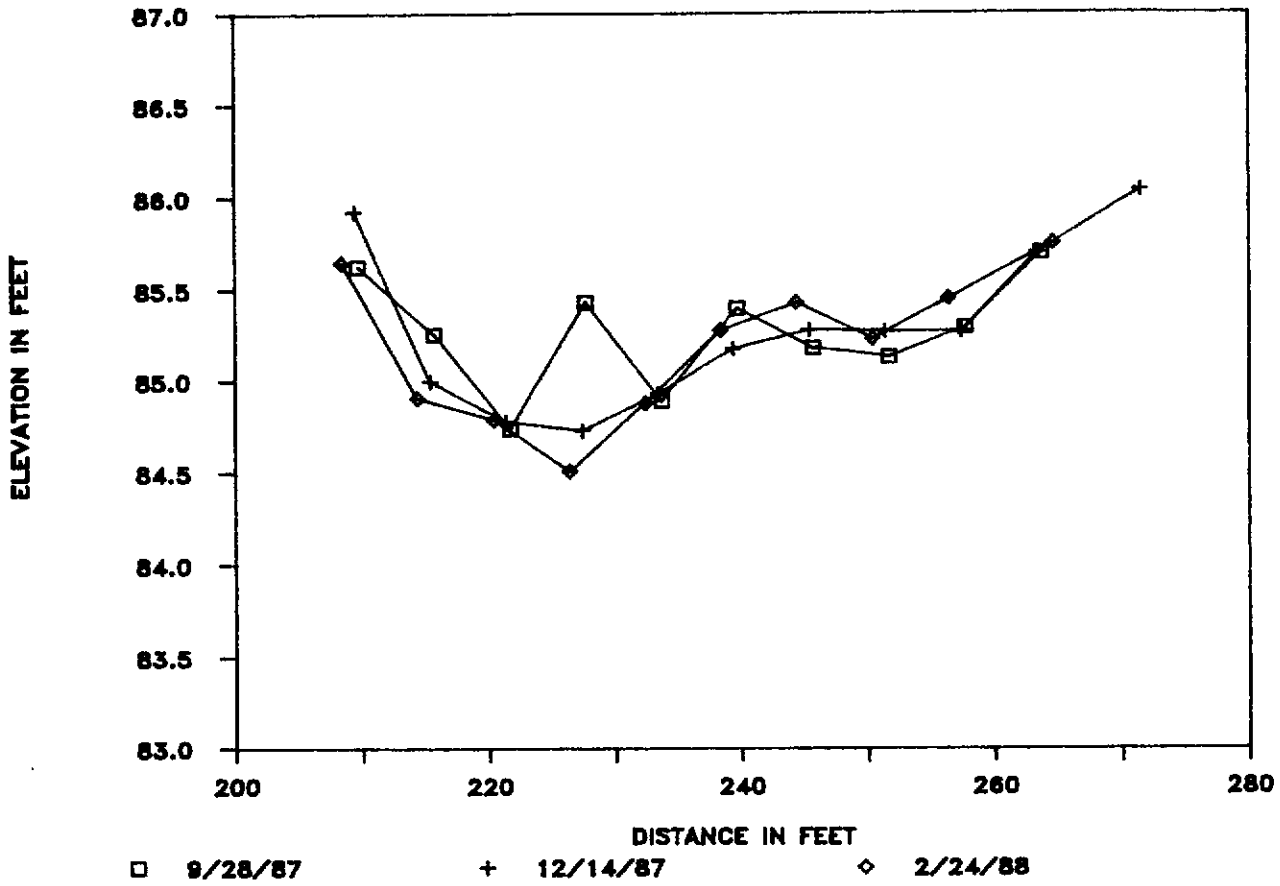

Figure 4. Changes in streambed elevation at North Fork Nooksack side-channel cross-section #2 during the spring chinook egg incubation period.

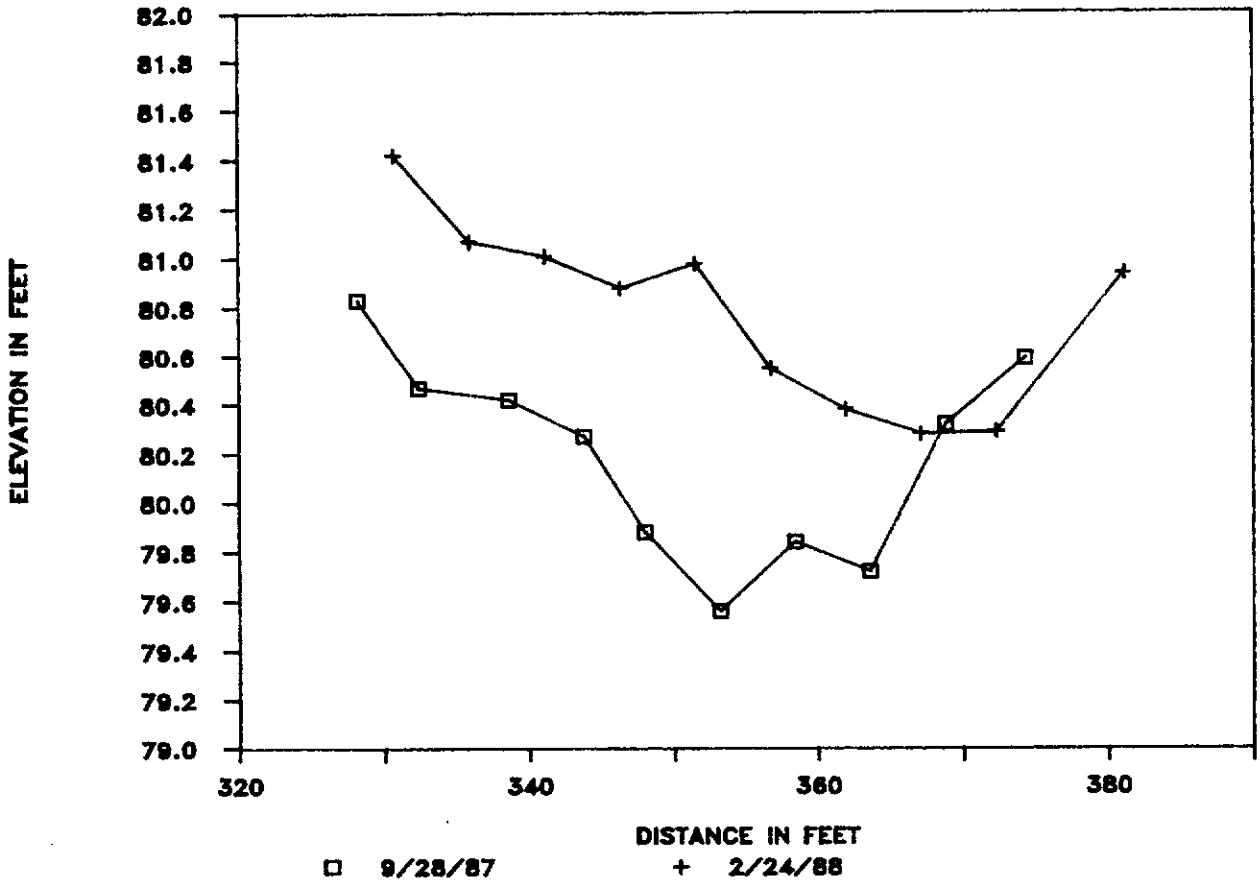

Figure 5. Changes in streambed elevation at North Fork Nooksack side-channel cross-section #3 during the spring chinook egg incubation period.

see and count. The spring chinook also spawn in somewhat different areas each year, partially in response to changes in channel configuration in the unstable, braided channel reaches of the North Fork.

A spring chinook population estimate for the entire Nooksack system was developed in 1985 using a reverse Peterson method (MacKay, paper in prep.). The estimate for spring chinook spawning naturally in the North Fork was 335.

Table 4 summarizes the USFWS spawning survey data for 1985, 1986 and 1987. The numbers for total spring chinook observed are the combined area totals for each year. They represent only a part of the total population, particularly in the mainstem North Fork where visibility is poor and foot access to available habitat is limited. The figure for expanded spring chinook includes redd counts where the estimate from redds exceeds the total spring chinook observed. Effort in total days and total miles surveyed is given for each year. Calculations were done for the following: fish per mile; expanded fish per mile; fish per day; and expanded fish per day.

Table 4. North Fork Nooksack spring chinook spawning survey data for 1985, 1986 and 1987 including the number of spring chinook observed; the expanded count which includes redd data; the number of days of effort; total river miles surveyed; and fish per unit effort.

YEAR	TOTAL SP CHIN OBSERVD	SPR CHIN EXPANDED (REDDS)	EFFORT IN DAYS	FISH PER DAY	EXPANDED FISH PER DAY	EFFORT IN MILES	FISH PER MILE	EXPANDED FISH PER MILE
1985	95	133	30	3.167	4.433	51.6	1.841	2.578
1986	82	118	27	3.037	4.370	58.9	1.392	2.003
1987	62	64	28	2.214	2.286	68.0	0.912	0.941

Fewer spring chinook were seen in 1987 than in either of the two previous years. The number of days of effort in 1987 was comparable to 1985 and 1986 while the number of miles covered was greater. The increase in miles covered is probably due to greater efficiency and to fewer fish in 1987 than in previous years.

The 1987 figures for fish/day, expanded fish/day, fish/mile and expanded fish/mile are all lower than in 1985 or 1986. By comparing the 1986 and 1987 figures for fish per unit effort with 1985, a population estimate for those years can be derived from the 1985 population estimate using the following formula.

A/B = C/X

Where:

A= 1985 fish per unit effort variable, ie F/D, EXF/D, F/M, or EXF/M.
B= 1985 Peterson N.F. population estimate (335 spring chinook).
C= 1986 (or 1987) fish per unit effort year variable, ie F/D, EXF/D, F/M, or EXF/M.
X= 1986 (or 1987) N.F. population estimate.

1986

	A	B	C	BxC/A=X	
fish/day ex	3.167	335	3.037	321	
fish/day	4.433	335	4.370	330	
fish/mile ex	1.841	335	1.392	253	
fish/mile	2.578	335	2.003	260	
				291	= avg. 1986 pop. estimat

1987

fish/day ex	3.167	335	2.214	234	
fish/day	4.433	335	2.286	173	
fish/mile ex	1.841	335	0.912	166	
fish/mile	2.578	335	0.941	122	
				174	= avg. 1987 pop. estimat

Using this method, population estimates were calculated for each variable and were averaged to arrive at an average population estimate of 291 for 1986 and 174 for 1987.

Redd Survival Studies

Adult spring chinook returns from brood years when severe storm related redd disturbance occurred are expected to be low. During the 1980's serious channel disturbance has been observed in brood years 1982, 1983, 1985 and 1986 (Schuett-Hames and Schuett-Hames 1987). Due to the potentially severe impact of redd loss on the depleted Nooksack spring chinook population, it is important for fisheries managers to monitor the extent of redd disturbance from year to year to improve run size predictions. Results from this initial year of North Fork redd survival studies are promising both in terms of methodology and results. Over time a redd survival database could be developed that would provide this information to fisheries managers. It may eventually be possible to develop a correlation between U.S. Geological Service (U.S.G.S.) peak flow data and redd survival for use as an indicator of future run strength.

The U.S.G.S. has records for the last 48 years, covering peak storm events for the North Fork Nooksack. The highest peak flow event during the 1987-88 incubation period was 1,380 cfs on December 6, 1987 (provisional data with a margin of error of plus or minus 20% until U.S.G.S. analysis is completed). This is the lowest peak flow for any year on record at the Glacier gauging station. Table 5 shows this

year's peak flow along with peak flows from other brood cycles in the 1980's.

Table 5. Peak discharges for the North Fork Nooksack near Glacier. 1987 and 1988 data are provisional at this time with an accuracy of + or - 20%. Data from the U.S. Geological Survey, Tacoma, Washington.

BROOD YEAR	DATE	PEAK DISCHARGE (CFS)
1980	12/80	8500
1981	10/81	4300
	11/81	3680
1982	10/82	5350
	12/82	6660
1983	01/84	9700
	11/83	4300
	11/83	4730
1984	10/84	4400
1985	10/85	7700
	01/86	5830
	02/86	3840
1986	11/86	2970
1987	12/87	1380

Based on 1987 - 1988 redd elevation measurements, it appears probable that the absence of major storm events is beneficial to survival of North Fork spring chinook in the intragravel stage.

CONCLUSIONS

1. Escapement to the North Fork Nooksack appeared to be lower in 1987 than in 1985 and 1986. A population of 174 North Fork Nooksack spring chinook was estimated for 1987 in comparison to 291 for 1986, and 335 for 1985.

2. Based on redd elevation measurements, redd survival was good fall and winter of 1987-88. This time period had the lowest peak flow ever recorded in 48 years of record. It appears probable that the absence of major storm events is beneficial to survival of North Fork spring chinook in the intragravel stage.

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APPENDIX I

1987 U.S. FISH AND WILDLIFE SERVICE NORTH FORK NOOKSACK SPRING CHINOOK SURVEY RESULTS

SURVEY LOCATION	RIVERMILE	DATE	PERCENT SEEN	NO. LIVE	NO. DEAD	TOTAL COUNT	NO. REDDS	COMMENTS (Nos. are WDF code)
TRIBUTARIES								
Bell Creek	0.0-0.1	08-Aug-87	80	0	0	0		20,57,60 too low
Bell Creek	0.0-spot	31-Aug-87	99	0	0	0		40,54,57
Boulder Creek	0.0-0.2	15-Aug-87	99	0	0	0		20,44
Boulder Creek	0.0-0.2	22-Aug-87	95	0	0	0		20
Boulder Creek	0.0-0.2	28-Aug-87	95	0	0	0		20,40
Boulder Creek	0.0-0.2	04-Sep-87	95	0	0	0		20,40
Boulder Creek	0.0-0.2	12-Sep-87	99	0	0	0		20,40,57
Boulder Creek	0.0-0.2	19-Sep-87	99	0	0	0		20
Boyd Creek	0.0-0.2	09-Aug-87	80	0	0	0		20
Boyd Creek	0.0-0.2	17-Aug-87	90	0	0	0		20,57
Boyd Creek	0.0-0.2	22-Aug-87	90	0	0	0		20,57
Boyd Creek	0.0-0.1	29-Aug-87	99	0	0	0		40,54
Boyd Creek	0.0-0.2	05-Sep-87	95	0	0	0		20,57
Boyd Creek	0.0-0.1	13-Sep-87	99	0	0	0		54
Canyon Creek	0.7-1.6	10-Aug-87	20	0	0	0		20,59,60 some gravel
Canyon Creek	0.0-0.7	10-Aug-87	20	0	0	0		20,59,60 chan. shift
Canyon Creek	0.0-1.5	16-Aug-87	40	0	0	0		21
Canyon Creek	0.7-1.5	24-Aug-87	50	5	0	5	2	20,31
Canyon Creek	0.0-0.7	24-Aug-87	50	0	0	0	1	20,31,40
Canyon Creek	0.0-0.7	30-Aug-87	70	0	0	0		09,23,31
Canyon Creek	0.7-1.5	30-Aug-87	50	2	0	2	3	20
Canyon Creek	0.0-0.7	07-Sep-87	50	0	0	0		20,31
Canyon Creek	0.7-1.5	07-Sep-87	50	0	1	1		20,60
Canyon Creek	0.0-0.7	14-Sep-87	90	0	0	0		23,34
Canyon Creek	0.7-1.5	14-Sep-87	50	0	0	0	3	20,33,40
Coal Creek	0.0-0.2	08-Aug-87	90	0	0	0		54,60 dry at mouth
Cornell Creek	0.0-0.6	09-Aug-87	95	0	0	0		20,40
Cornell Creek	0.0-0.6	17-Aug-87	95	0	0	0		20,40,57
Cornell Creek	0.0-0.6	23-Aug-87	90	0	0	0		20
Cornell Creek	0.0-0.6	31-Aug-87	90	0	0	0		54,57
Cornell Creek	0.0-0.6	05-Sep-87	80	0	0	0		20,49,57
Cornell Creek	0.0-0.6	13-Sep-87	90	0	0	0		60
Deadhorse Creek	0.0-0.1	09-Aug-87	95	0	0	0		23
Deadhorse Creek	0.0-0.1	17-Aug-87	70	0	0	0		20,59,60
Deadhorse Creek	0.0-0.1	22-Aug-87	90	0	0	0		20
Deadhorse Creek	0.0-0.1	29-Aug-87	70	0	0	0		20,31
Deadhorse Creek	0.0-0.2	05-Sep-87	95	0	0	0		20
Deadhorse Creek	0.0-0.1	13-Sep-87	99	0	0	0		20
Gallup Creek	0.0-0.3	09-Aug-87	95	0	0	0		20,40,59
Gallup Creek	0.0-0.3	23-Aug-87	90	0	0	0		20,41
Gallup Creek	0.0-0.3	31-Aug-87	90	0	0	0		20,57
Glacier Creek	0.0-0.2	09-Aug-87	5	0	0	0		25,38

SURVEY LOCATION	RIVERMILE	DATE	PERCENT SEEN	NO. LIVE	NO. DEAD	TOTAL COUNT	NO. REDDS	COMMENTS (Nos. are WDF code)
Glacier Creek	0.0-0.2	23-Aug-87	5	0	0	0		38
Glacier Creek	0.0-0.2	31-Aug-87	5	0	0	0		09,38
Hedrick Creek	0.0-0.2	09-Aug-87	95	0	0	0		20,57
Hedrick Creek	0.0-0.2	17-Aug-87	95	0	0	0		40,57,60
Hedrick Creek	0.0-0.2	23-Aug-87	90	0	0	0		57
Hedrick Creek	0.0-0.2	31-Aug-87	95	0	0	0		40,57
Hedrick Creek	0.0-0.2	13-Sep-87	90	0	0	0		20,57
Kendall Creek	0.0-0.2	15-Aug-87	25	0	0	0		60
Kendall Creek	0.0-0.2	21-Aug-87	10	3	0	3	1	23,38
Kendall Creek	0.0-0.2	28-Aug-87	50	8	0	8	1	20
Kendall Creek	0.0-0.2	06-Sep-87	50	2	0	2		24,38
Kendall Creek	0.0-0.2	11-Sep-87	50	2	7	9	1	23,38
Kendall Creek	0.0-0.2	18-Sep-87	80	0	4	4	6	20
Kenny Creek	0.0-0.1	08-Aug-87	95	0	0	0		20,40,60
Kenny Creek	0.0-0.1	31-Aug-87	99	0	0	0		20,57
Maple Creek	0.0-0.4	15-Aug-87	90	0	0	0		23
Maple Creek	0.0-0.4	23-Aug-87	80	0	0	0		20
Maple Creek	0.0-0.4	28-Aug-87	80	0	0	0		20
Maple Creek	0.0-0.4	04-Sep-87	70	0	0	0		20,40
Maple Creek	0.0-0.4	12-Sep-87	90	0	0	0		20,40
Racehorse Creek	0.0-1.4	15-Aug-87	80	0	0	0		20
Racehorse Creek	0.0-0.8	21-Aug-87	90	0	0	0		20
Racehorse Creek	0.0-0.8	28-Aug-87	90	0	0	0		20,57
Racehorse Creek	0.0-0.8	06-Sep-87	95	0	0	0		08,20
Racehorse Creek	0.0-0.8	11-Sep-87	90	0	0	0		20,57
Thompson Creek	0.0-0.3	05-Sep-87	90	0	0	0		20
N.F. NOOKSACK MAINSTEM REACHES								
N.F. (Bell)	40.8-41.1	31-Aug-87	5	0	0	0		25,60
N.F. (Bell)	40.8-41.1	11-Sep-87	10	0	0	0		04,08,38
N.F. (Kenny)	42.1-spot	08-Aug-87	5	0	0	0		05,25,38
N.F. (Kenny)	41.5-42.5	21-Aug-87	10	0	0	0		04,08,38
N.F. (Kenny)	42.1-42.4	31-Aug-87	5	0	0	0		05,09,38
N.F. (Kenny)	41.5-42.5	06-Sep-87	5	0	0	0		08,38
N.F. (Kenny)	41.5-42.5	11-Sep-87	10	0	0	0		04,08,38
N.F. (Racehorse Sl.)	45.0-45.6	15-Aug-87	5	0	0	0		38
N.F. (Racehorse Sl.)	45.0-45.1	21-Aug-87	10	0	0	0		38
N.F. (Racehorse Sl.)	45.0-45.1	28-Aug-87	15	0	0	0		22,38
N.F. (Racehorse Sl.)	45.0-45.1	06-Sep-87	10	0	0	0		22,38
N.F. (Racehorse Sl.)	45.0-45.1	11-Sep-87	10	0	0	0		22,38
N.F. (Johnies Slough)	0.0-0.1	15-Aug-87	90	0	0	0		20
N.F. (Johnies Slough)	0.0-0.1	21-Aug-87	90	0	0	0		20
N.F. (Johnies Slough)	0.0-0.1	28-Aug-87	90	0	0	0		20,48
N.F. (Johnies Slough)	0.0-0.1	06-Sep-87	90	0	0	0		20,48
N.F. (Johnies Slough)	0.0-0.1	11-Sep-87	95	0	0	0		20,48
N.F. (Racehorse)	45.0-45.1	08-Aug-87	5	0	0	0		05,09,38
N.F. (Racehorse)	45.0-45.6	15-Aug-87	5	0	0	0		09,38
N.F. (Racehorse)	45.0-45.7	21-Aug-87	10	0	0	0		09,28,38
N.F. (Racehorse)	45.0-45.7	28-Aug-87	10	0	0	0		09,38

SURVEY LOCATION	RIVERMILE	DATE	PERCENT SEEN	NO. LIVE	NO. DEAD	TOTAL COUNT	NO. REDDS	COMMENTS (Nos. are WDF code)
N.F. (Racehorse)	45.0-45.7	06-Sep-87	5	0	2	2		09,25,38
N.F. (Racehorse)	45.0-45.7	11-Sep-87	10	0	0	0		09,25,38
N.F. (Coal)	45.1-45.3	08-Aug-87	5	0	0	0		08,25,38
N.F. (Coal)	44.4-45.5	18-Sep-87	10	0	2	2		04,21
N.F. (Kendall)	45.6-46.0	15-Aug-87	5	1	0	1		04,08,38
N.F. (Kendall)	45.6-46.1	28-Aug-87	10	0	0	0		04,08,38
N.F. (Kendall)	45.6-46.1	06-Sep-87	10	0	0	0		04,38
N.F. (Kendall)	45.6-46.1	11-Sep-87	10	3	0	3		04,08,38
N.F. (Kendall)	45.6-46.1	18-Sep-87	50	0	1	1		04,08,21
N.F. (Harris Farm)	47.0-47.6	16-Aug-87	10	0	0	0		04,60
N.F. (Harris Farm)	46.9-47.6	24-Aug-87	10	2	0	2		04,05,38
N.F. (Harris Farm)	46.9-47.6	30-Aug-87	5	2	0	2		04,05,38
N.F. (Harris Farm)	46.9-47.6	07-Sep-87	5	2	3	5		04,05,60
N.F. (Harris Farm)	46.9-47.6	14-Sep-87	10	1	1	2		22,34,38
N.F. (Harris Farm)	46.8-47.6	19-Sep-87	30	0	3	3		04,08,60
N.F. (Glen)	48.0-48.3	24-Aug-87	5	0	0	0		04,08,38
N.F. (Glen)	47.6-48.3	30-Aug-87	5	0	0	0		04,08,38
N.F. (Glen)	47.6-48.3	07-Sep-87	10	0	2	2		04,08,38
N.F. (Glen)	47.6-48.3	14-Sep-87	10	0	2	2		04,08,38
N.F. (Glen)	47.8-48.5	18-Sep-87	50	0	0	0		04,08,21
N.F. (Maple)	49.7-49.8	15-Aug-87	5	0	0	0		08,38
N.F. (Maple)	49.7-49.8	04-Sep-87	5	0	0	0		08,38
N.F. (Maple)	49.7-49.8	12-Sep-87	5	0	0	0		08,38
N.F. (Aldrich)	51.3-51.8	08-Aug-87	5	0	0	0		05,09,25
N.F. (Aldrich)	51.3-52.0	23-Aug-87	10	0	0	0		05,09,38
N.F. (Aldrich)	51.3-51.5	12-Sep-87	5	0	0	0		04,08,38
N.F. (Boulder, lower)	51.5-52.2	15-Aug-87	5	0	0	0		04,08,38
N.F. (Boulder, lower)	51.5-52.2	22-Aug-87	10	0	0	0		04,08,38
N.F. (Boulder, lower)	51.5-52.2	28-Aug-87	10	0	0	0		04,08,38
N.F. (Boulder, lower)	51.5-52.2	04-Sep-87	15	0	0	0		04,08,38
N.F. (Boulder, lower)	51.5-52.2	12-Sep-87	10	0	4	4		04,08,38
N.F. (Boulder, lower)	51.5-52.2	19-Sep-87	60	0	1	1		04,08,38
N.F. (Boulder, upper)	52.2-52.5	22-Aug-87	10	11	0	11		04,08,38
N.F. (Boulder, upper)	52.2-52.5	28-Aug-87	10	20	1	21		04,08,38
N.F. (Boulder, upper)	52.2-52.5	04-Sep-87	20	12	2	14		04,08,38
N.F. (Boulder, upper)	52.2-52.5	12-Sep-87	10	1	2	3		04,08,24
N.F. (Boulder, upper)	52.2-52.5	19-Sep-87	40	0	2	2		04,08,60
N.F. (Canyon)	54.7-55.2	10-Aug-87	2	0	0	0		08,25,38
N.F. (Canyon)	54.7-55.2	16-Aug-87	10	0	0	0		04,08
N.F. (Canyon)	54.7-55.2	24-Aug-87	5	0	0	0		04,08,22
N.F. (Canyon)	54.8-55.5	30-Aug-87	10	0	1	1		05,38
N.F. (Canyon)	54.8-55.5	07-Sep-87	10	0	0	0		04,08,38
N.F. (Canyon)	54.8-55.5	14-Sep-87	10	0	1	1		04,08,38
N.F. (Hedrick)	55.8-56.2	09-Aug-87	5	0	0	0		05,09,38
N.F. (Hedrick)	55.8-56.3	17-Aug-87	10	0	0	0		05,09,38
N.F. (Hedrick)	55.8-56.2	23-Aug-87	10	0	0	0		05,09,38
N.F. (Hedrick)	55.8-56.3	31-Aug-87	70	0	0	0		05,09,25
N.F. (Hedrick)	55.8-56.2	05-Sep-87	80	0	0	0		04,08,23
N.F. (Hedrick)	55.8-56.2	13-Sep-87	90	0	0	0		05, 20
N.F. (Gallup)	57.4-57.6	09-Aug-87	5	0	0	0		09,38
N.F. (Gallup)	57.4-57.6	23-Aug-87	10	0	0	0		05,09,38

SURVEY LOCATION	RIVERMILE	DATE	PERCENT SEEN	NO. LIVE	NO. DEAD	TOTAL COUNT	NO. REDDS	COMMENTS (Nos. are WDF code)
N.F. (Gallup)	57.4-57.6	31-Aug-87	5	0	0	0		08,35,38
N.F. (Boyd)	62.0-62.3	09-Aug-87	5	0	0	0		05,09,38
N.F. (Boyd)	62.0-62.6	17-Aug-87	5	0	0	0		05,09,38
N.F. (Boyd)	62.0-62.3	22-Aug-87	10	0	0	0		04,08,38
N.F. (Boyd)	62.0-62.6	29-Aug-87	15	0	0	0		05,09,38
N.F. (Boyd)	62.0-62.7	05-Sep-87	10	0	0	0		05,09,38
N.F. (Boyd)	62.0-62.3	13-Sep-87	25	0	0	0		05,09,21
N.F. (Nooksack Camp)	62.3-62.7	13-Sep-87	25	0	0	0		04,08,21
N.F. (Bridge)	62.7-62.9	09-Aug-87	5	0	0	0		05,09,38
N.F. (Bridge)	62.7-63.0	17-Aug-87	30	0	0	0		05,09,38
N.F. (Bridge)	62.7-63.0	22-Aug-87	10	0	0	0		05,09,38
N.F. (Bridge)	62.7-63.0	29-Aug-87	10	0	0	0		05,09,38
N.F. (Bridge)	62.7-63.0	05-Sep-87	10	0	0	0		09,38
N.F. (Bridge)	62.7-63.0	13-Sep-87	25	0	0	0		05,09,21
N.F. (Deadhorse)	63.3-63.5	09-Aug-87	5	0	0	0		05,09,38
N.F. (Deadhorse)	63.3-63.5	17-Aug-87	50	0	0	0		05,09,60
N.F. (Deadhorse)	63.3-63.5	22-Aug-87	10	0	0	0		05,09,38
N.F. (Deadhorse)	63.3-63.5	29-Aug-87	50	0	0	0		05,09,38
N.F. (Deadhorse)	63.3-63.5	05-Sep-87	10	0	0	0		05,09,38
N.F. (Deadhorse)	63.3-63.5	13-Sep-87	25	0	0	0		05,09,21
N.F. (Powerhouse)	64.1-64.5	09-Aug-87	5	0	0	0		08,38
N.F. (Powerhouse)	64.1-64.5	13-Sep-87	25	0	0	0		04,08,21
N.F. (Powerhouse)	64.2-64.5	29-Aug-87	5	0	0	0		21,38